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[54] HAND-HELD POWER TOOL WITH ANTIVIBRATION MOUNT

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[51] **Int. Cl.** **B27b 17/02**

[58] **Field of Search** ..... 173/162; 248/9; 143/32 R

[56] **References Cited**

UNITED STATES PATENTS

2,538,954	1/1951	Efromson et al.	248/9
2,894,489	7/1959	Clay	173/162
3,139,152	6/1964	Bager	248/9 X
3,224,473	12/1965	Dobbertin et al.	173/162 X
3,372,718	3/1968	Irgens	173/162 X
3,409,056	11/1968	Rauh	173/162 X
3,542,095	11/1970	Frederickson et al.	173/162 X

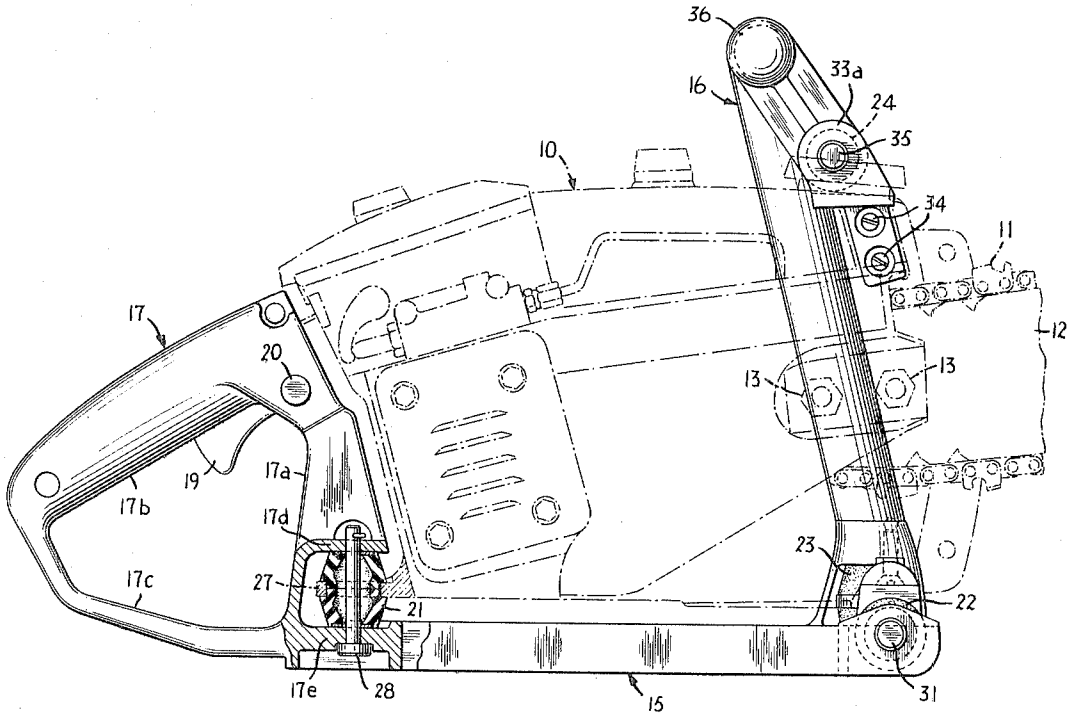
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[57] **ABSTRACT**

A hand-held power tool comprises an internal combustion engine on which a power tool is mounted and by which it is driven. The engine is mounted by vibration isolators on an essentially rigid supporting structure comprising a base portion, a front handle and a rear handle. Four vibration isolators are so arranged as to isolate the supporting structure from vibration of the engine while providing effective control of the tool by an operator holding the supporting structure by the front and rear handles. The vibration isolators are shown in the form of hollow barrel-shaped bodies of elastomeric material.

13 Claims, 4 Drawing Figures



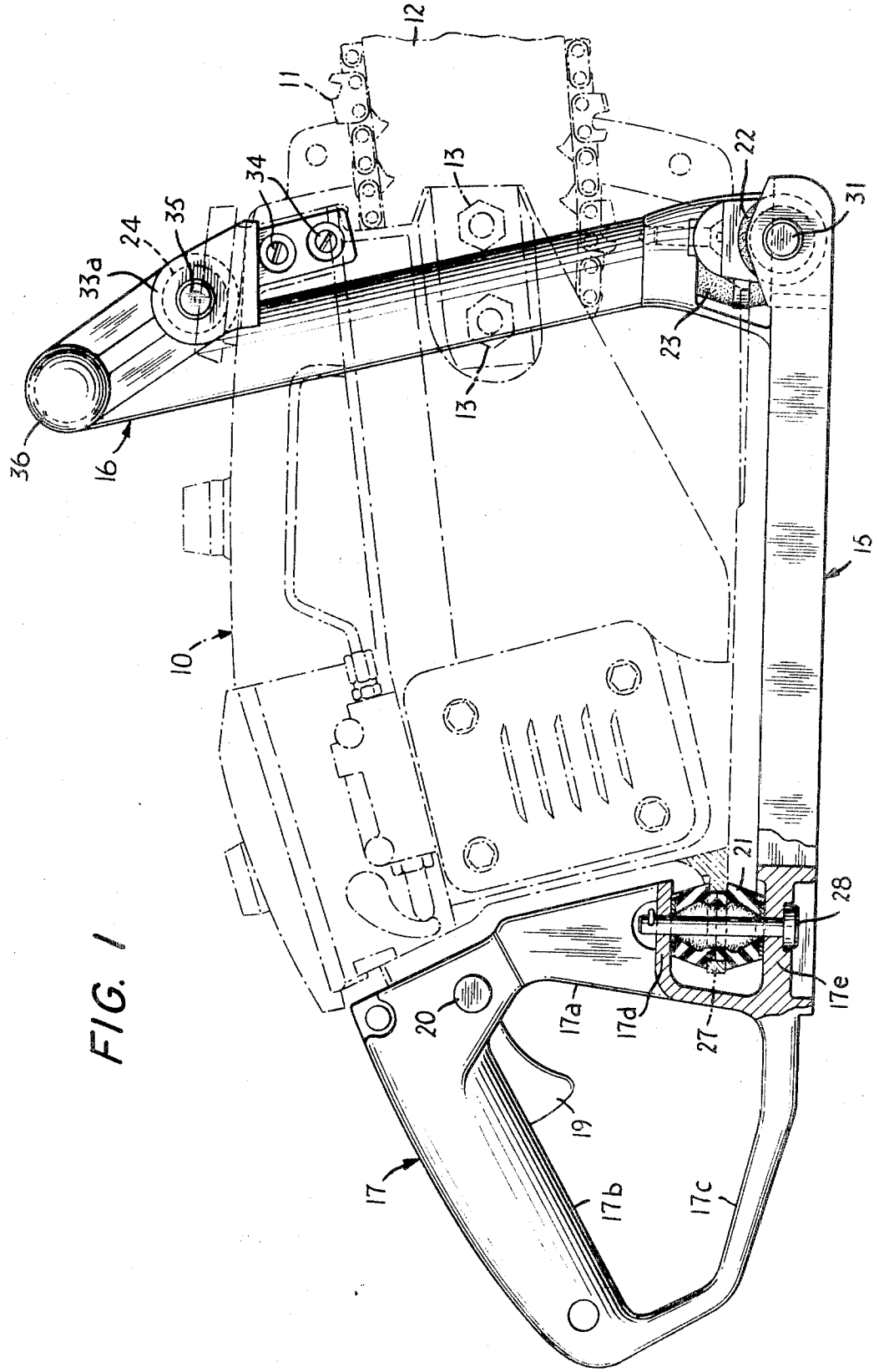
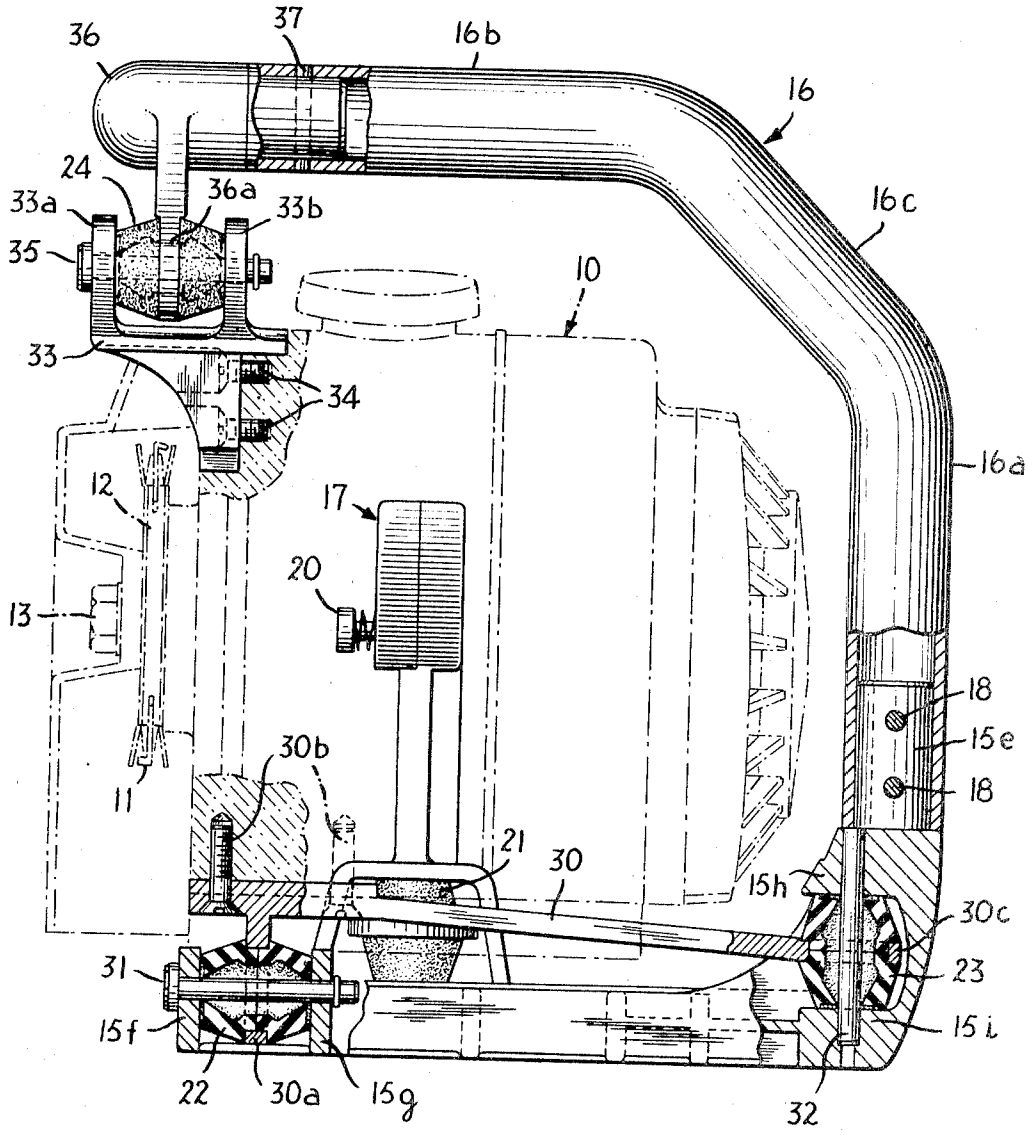

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33a
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17e
17a
17d
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17b
17c

FIG. 1

FIG. 2


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16b
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33a
36a
33b
16c
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16a
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15e
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15h
30c
31
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15f
15i
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30a
15g
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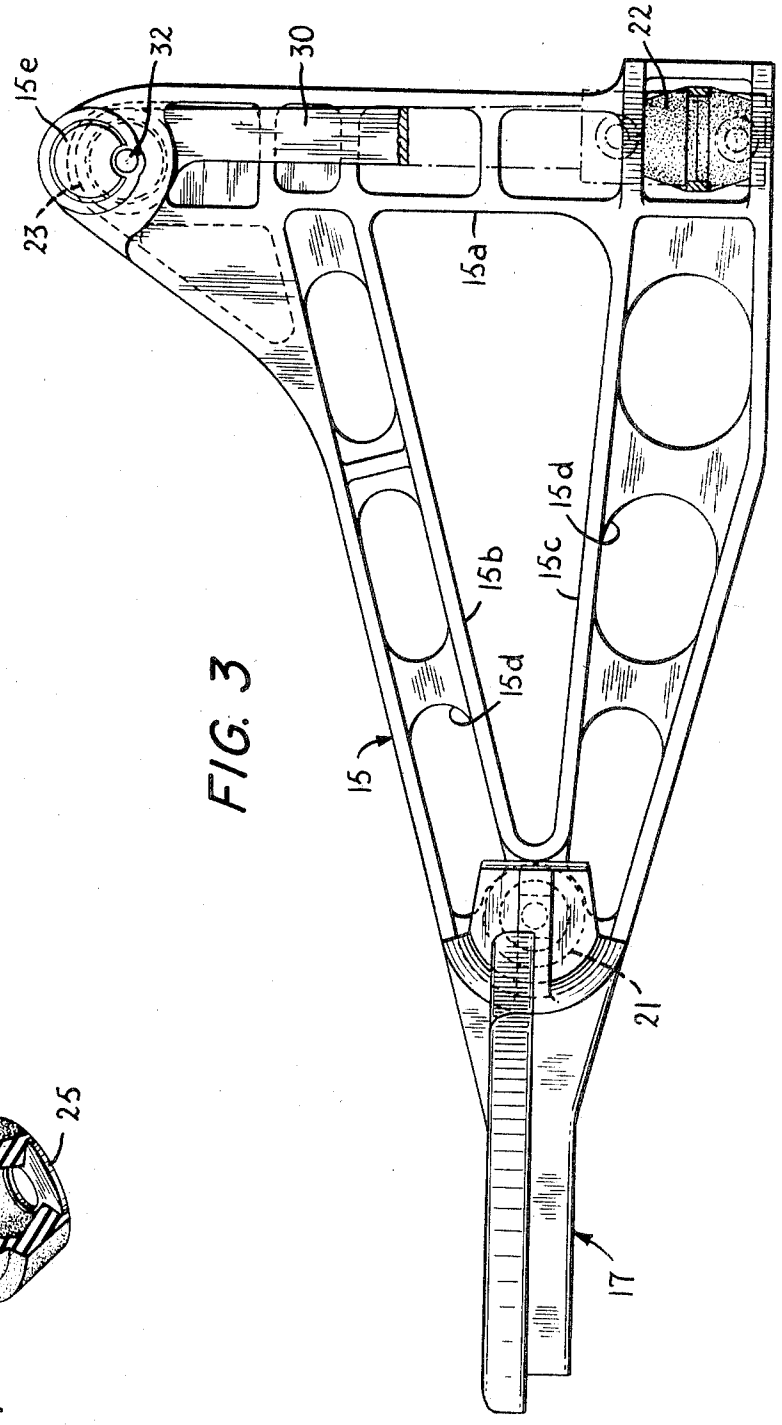


FIG. 3

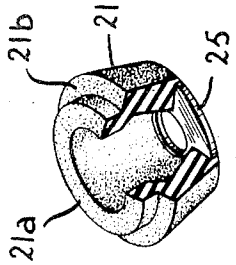


FIG. 4

HAND-HELD POWER TOOL WITH ANTIVIBRATION MOUNT

The present invention relates to engine-driven hand-held power tools and in particular to tools powered by small internal combustion engines. While the invention is herein illustrated and described with reference to a chain saw, it will be understood that it is applicable to other hand-held power tools.

Chain saws and other hand-held power tools are commonly driven by a small light weight internal combustion engine normally operating at a speed of over 5,000 r.p.m. The chain saw cutter bar or other tool is commonly mounted on an engine chassis and the latter is provided with suitable handles by means of which the engine and tool are held and manipulated by an operator.

A small engine of the kind used for hand-held power tools unavoidably generates vibration. This is particularly true of small two-cycle single-cylinder internal combustion engines operating at high speed. The vibration of the engine transmitted through the handles to the operator has been found to cause early fatigue and, in some instances, numbness of the arms. The operator's control of the tool is thereby impaired, thus creating a safety hazard. Moreover, continued use of the power tool over an extended period of time may cause serious impairment of the operator's health.

It has been proposed to reduce the vibration transmitted to the operator by providing vibration isolators between the handles and the engine. However, vibration isolators having a sufficiently soft action to be effective in reducing transmission of vibration to the handles permit relative movement between the handles and the tool and hence make it impossible for the operator to control the tool effectively.

It is an object of the present invention to attenuate the vibration transmitted by a chain saw or other engine-driven power tool to the operator while, at the same time, providing the operator with precise control of the tool at all times. In accordance with the invention, the engine is mounted by means of vibration isolators on an essentially rigid supporting structure having front and rear handles by which the tool is held. The isolators are so arranged as to isolate the supporting structure from the vibration of the engine while providing a sufficiently firm connection between the supporting structure and the engine to afford precise control of the tool mounted on, and driven by, the engine.

In an illustrated embodiment of the invention, the vibration isolators by means of which the engine is mounted on the supporting structure comprise hollow barrel-shaped bodies of elastomeric material having an annular circumferential groove midway between opposite ends. The vibration isolators are mounted between the engine and the supporting structure by cooperating mounting fixtures one of which engages opposite ends of the barrel-shaped body while the other comprises a ring seated in the circumferential groove. A pin extending through the barrel-shaped body and the ring provides a fail-safe feature in that, even if the elastomer body fails, the pin of one fixture extends through the ring portion of the other fixture and thus provides a secure connection between the engine and the supporting structure.

The vibration isolators have the characteristic of being stiffer in one direction and more flexible in a direction perpendicular thereto. By selectively arranging the isolators with respect to the principal mode of vibration of the engine, it has been found possible to isolate the engine from the supporting structure while, at the same time, providing a sufficiently firm connection between the supporting structure and the engine to afford adequate control of the tool by the operator.

The objects and advantages of the invention will be more fully understood from the following description of a preferred embodiment of the invention shown by way of example in the drawings, in which:

FIG. 1 is a side view of a chain saw in accordance with the invention, the engine being shown in phantom and portions being broken away in order to show more clearly the mounting of the vibration isolators;

FIG. 2 is a front elevation of the chain saw with the engine and cutter bar shown in phantom and with portions broken away and shown in section;

FIG. 3 is a plan view of the supporting structure with the engine removed; and

FIG. 4 is a perspective view of one-half of a vibration isolator shown partially in section.

A hand-held power tool in accordance with the present invention is shown by way of example in the drawings as a chain saw having an engine **10** driving a saw chain **11** running on a guide bar **12** which is mounted on the right-hand side of the engine by means of studs and nuts **13** and projects forwardly. The engine **10** is shown as a single-cylinder two-stroke-cycle internal combustion engine having a crankshaft the axis of which is horizontal when the engine is in a normal upright position, as shown in FIG. **1**, and extends transversely of the engine in line with the sprocket by which the chain **11** is driven. The engine cylinder extends rearwardly from the crankshaft and is approximately horizontal although it may be somewhat inclined. The engine is air-cooled and is constructed largely of light weight metals and alloys in order to minimize the weight of the chain saw. It is designed to run at relatively high speeds, for example speeds in the range of 5,000 to 8,000 r.p.m.

Although the crankshaft is counterbalanced, the engine develops vibration, particularly when operating at high speed. The principal mode of vibration is in a fore-and-aft direction because of the reciprocation of the engine piston. There are other modes of vibration due, for example, to the rotation of the crankshaft and the throw of the connecting rod. The center of vibration is approximately at the intersection of the axes of the cylinder and the crankshaft. Because of the cutter bar being mounted on the right side of the engine, the center of mass of the engine saw assembly is laterally offset from the center of vibration. This results in the generation of a couple producing an oscillatory vibration of the engine.

If handles for holding and manipulating the chain saw were affixed directly on the engine chassis in accordance with prior practice, the vibration of the engine would be transmitted to the operator with the ill effects referred to above. However, in accordance with the invention, the handles are not secured on the chassis but are part of a supporting structure on which the engine is mounted by means of vibration isolators so as to isolate the vibration of the engine from the handles.

In the embodiment illustrated in the drawings, the supporting structure comprises a base portion **15**, a front handle **16** and a rear handle **17**. The base portion **15** is generally triangular with a transversely extending forward portion **15*a*** and two rearwardly converging side portions **15*b*** and **15*c*** which, in cross section, are preferably of channel or I-beam section in order to provide strength and stiffness with minimum weight. The weight of the structure is further reduced by openings **15*d***.

The front handle **16** is shown formed of tubular stock which is shaped to provide an upwardly extending side portion **16*a*** and a horizontal top portion **16*b*** joined by an inclined portion **16*c***. The lower end of the side portion **16*a*** fits over an upwardly projecting portion **15*e*** provided at the forward left-hand corner of the base and is secured by transversely extending pins or rivets **18**. The tubing forming the handle **16** is of sufficient weight and diameter, for example 1¼ inch, as to be essentially rigid. The front handle preferably slopes somewhat rearwardly, as seen in FIG. **1**, so that the upper horizontal portion **16*b*** is located above the front end portion of the engine.

The rear handle **17** is somewhat D-shaped with an upwardly extending forward portion **17*a***, a downwardly inclined pistol grip portion **17*b*** and a lower guard portion **17*c***. Suitable engine controls are associated with the rear handle, including a trigger **19** controlling the throttle of the engine and a throttle lock button **20** which is pressed inwardly when starting the engine. While the rear handle **17** may be made as a separate member and rigidly secured to the base portion **15**, it is shown as being integral with the base portion. Thus, the supporting structure comprising the base portion **15**, front handle **16** and

rear handle 17 constitute a unitary structure which is essentially rigid so as to avoid objectionable flexing under the forces imposed on it in use.

The engine is mounted on the supporting structure comprising the base portion 15 and handles 16 and 17 by four vibration isolators 21, 22, 23 and 24. The vibration isolators are so selected and so located as to provide effective isolation between the engine and the supporting structure while at the same time affording the operator full control of the chain saw. While spring or other types of vibration isolators can be used if desired, the vibration isolators shown by way of example in the drawings are hollow barrel-shaped bodies of elastomeric material having metal washers 25 set in opposite ends. The isolators may be molded as complete units or may be made in two halves, one of which is illustrated in FIG. 4. Reduced end surfaces 21*a* of the halves are then bonded together, for example adhesively or by vulcanizing, so as to form a complete barrel-shaped body with an annular circumferential groove 21*b* midway between the ends. It will be seen that each half of the isolator is approximately frustoconical. The maximum diameter is, for example, 40 percent greater than the minimum diameter and the wall thickness is, for example, approximately 30 percent of the minimum diameter. The overall length is, for example, about 65 percent greater than the minimum diameter and hence somewhat greater than the maximum diameter of the isolator. The material from which the isolator is formed is an elastomeric material, for example a natural or synthetic rubber compound, e.g., polyurethane, having a suitable durometer value. For the wall thickness and proportions shown by way of example in the drawings, the durometer value is between 35 and 55 and preferably between 40 and 45. If the material is not itself resistant to oil, gas or other fluid hydrocarbons, the isolator is provided with an outer layer or coating of elastomeric material having such resistance.

Each of the vibration isolators is mounted by means of a first fixture engaging its opposite ends and a second fixture having a ring portion received in the annular circumferential groove 21*b* of the isolator. The individual vibration isolators are mounted in selected locations and selected positions to provide good vibration isolation between the engine and the supporting structure while, at the same time, affording the operator effective control of the position of the engine and hence of the cutting bar of the chain saw. The configuration of the isolators is such that they are stiffer in the direction of their longitudinal axis and more flexible in a direction perpendicular to the axis. Preferably, the flexibility of the isolator is approximately twice as great in a transverse direction as in the direction of the central axis.

The vibration isolator 21 supporting the engine at its rear is disposed vertically between spaced portions 17*d* and 17*e* of the rear handle 17 engaging opposite ends of the isolator. A fixture 27 having a ring portion received in the central circumferential groove of the isolator is integral with, or secured on, the lower rear end portion of the engine chassis which is thereby supported by the vibration isolator 21. A pin 28 extends axially through the vibration isolator 21 and through aligned holes in the supporting portions 17*d* and 17*e*. It will be seen that, even if the vibration isolator should fail, the rear end portion of the engine is still captured by reason of the pin 28 passing through the ring portion of the fixture 27 on the engine chassis.

The second vibration isolator 22 is located at the front of the engine and is positioned with its axis horizontal and approximately parallel to the crankshaft. The opposite ends of the vibration isolator 22 are engaged by spaced portions 15*f* and 15*g* of the base portion 15. The circumferential groove of the vibration isolator is engaged by a ring portion 30*a* of a fixture 30 secured to the bottom of the engine near the front in suitable manner, for example by screws 30*b*. A pin 31 extends axially through the isolator 22 and through aligned holes in the supporting portions 15*f* and 15*g*.

The third vibration isolator 23 is located at the front of the engine on the lower left-hand side and is positioned with its axis vertical. Opposite ends of the isolator are engaged by spaced portions 15*h* and 15*i* of the base 15. A pin 32 extends axially through the isolator and is received in aligned holes in the portions 15*h* and 15*i* of the base. A ring portion 30*c* of the fixture 30 is received in the circumferential groove midway between the ends of the isolator 23.

The fourth vibration isolator 24 is located at the front of the engine and on the upper right-hand side and is positioned with its axis approximately horizontal and parallel to the crankshaft of the engine. Opposite ends of the isolator are engaged by portions 33*a* and 33*b* of a fixture 33 suitably secured to the engine chassis, for example by screws 34. A pin 35 extends axially through the vibration isolator 24 and through aligned holes in the opposite portions 33*a* and 33*b* of the fixture 33. The circumferential groove of the vibration isolator 24 is engaged by a ring portion 36*a* of a fixture 36 which fits into the upper right-hand portion of the front handle 16 and is suitably secured, for example by a pin 37.

The space between the portions which engage opposite ends of each of the isolators, for example the portions 17*d* and 17*e* engaging opposite ends of the isolator 21, are spaced apart a distance less than the overall length of the isolator when in unconfined condition so that the isolator is compressed in an axial direction when it is placed between the supporting surfaces engaging its opposite ends. For example, an isolator which in uncompressed condition is 1.31 inches long is compressed between the supporting surfaces to 1.25 inches. The vibration isolator is sufficiently compressible circumferentially to permit the isolator to be drawn into the ring portion of the central support, for example the ring 27 with respect to the isolator 21, prior to the isolator being compressed in an axial direction. The ring thereupon snaps into the central circumferential groove of the isolator. When the isolator is confined in an axial direction, it is no longer compressible circumferentially and hence the ring is securely held in the circumferential groove of the isolator.

It will be seen that the four vibration isolators supporting the engine 10 are located at the apices of a tetrahedron. Three of the isolators are located at the front of the engine with two of them below the engine and at opposite sides while the third is located above the engine and at one side. The fourth vibration isolator 21 is located at the rear of the engine. Two of the vibration isolators, namely isolators 22 and 24, are positioned with their axis approximately horizontal and parallel with the crankshaft of the engine while the other two isolators, 21 and 23, are positioned with their axes vertical. It will be noted that in all instances the axes of the isolators are perpendicular to a fore-and-aft direction and hence approximately perpendicular to the axis of the engine cylinder. By reason of the isolators having a higher spring constant in a direction axial of the isolator and a lower spring constant in a direction perpendicular to the axis, and by reason of the location and positioning of the isolators as described, the transmission of engine vibration to the supporting structure comprising the front and rear handles is effectively attenuated. However, an operator holding the chain saw by the front and rear handles has effective control of the chain saw and can accurately position the cutter bar both vertically and laterally.

While a preferred embodiment of the invention has been illustrated by way of example in the drawings and is herein particularly described, it will be understood that the invention is in no way limited to this embodiment.

What we claim and desire to secure by letters patent is:

1. An engine-driven hand-held power tool comprising an engine having a front portion and a rear portion, a tool mounted on and driven by said engine, an engine-supporting structure comprising a base portion, a front handle and a rear handle, said base portion and handles constituting a unitary essentially rigid structure, and means mounting said engine on said supporting structure comprising three vibration isolators supporting the front portion of said engine on said supporting structure and a fourth vibration isolator supporting the rear portion of said engine on said supporting structure, said vibra-

tion isolators being arranged to isolate said supporting structure from vibration of said engine while providing control of said tool by an operator holding said supporting structure by said handles.

2. An engine-driven hand-held power tool according to claim 1, in which each of said isolators is stiffer in the direction of a central axis and more yielding in a direction perpendicular to said axis.

3. An engine-driven hand-held power tool according to claim 2, in which said isolator supporting the rear portion of the engine and at least one of the isolators supporting the front portion of the engine have their said axes approximately vertical in a normal operating position of said power tool.

4. An engine-driven hand-held power tool according to claim 3, in which two of said isolators supporting the front portion of said engine have said axis horizontal.

5. An engine-driven hand-held power tool comprising an engine having a front portion and a rear portion, an operating tool mounted on and driven by said engine, an engine-supporting structure comprising a front handle, a rear handle and a connecting portion, said handles and connecting portion constituting a unitary essentially rigid structure, and means mounting said engine on said supporting structure comprising a plurality of vibration isolators and associated mounting means on said supporting structure and said engine respectively, each of said isolators comprising a hollow barrel-shaped body of elastomeric material having opposite ends and an annular circumferential groove between said ends, said mounting means comprising respectively a support having portions engaging opposite ends of said isolator and a ring received in said annular groove.

6. An engine-driven hand-held power tool according to claim 5, in which at least the exposed outer surface of said elastomeric material is resistant to fluid hydrocarbons.

7. An engine-driven hand-held power tool according to claim 5, in which said elastomeric body is in a compressed condition between said portions of the support engaging opposite ends of said body.

8. An engine-driven hand-held power tool according to claim 5, in which a pin connecting said portions engaging opposite ends of said body extends axially through said body and through said ring.

9. An engine-driven hand-held power tool according to claim 5, in which said engine has a crankshaft arranged horizontally and transversely and a cylinder arranged with a central axis extending in an approximately fore-and-aft direction, and in which said mounting means comprises three of said isolators at the front portion of the engine and a fourth said isolator at the rear portion of the engine, two of said isolators at the front portion of the engine being arranged with central axes approximately parallel to said crankshaft, and the third said isolator at the front portion of the engine and said isolator at the rear portion of the engine being arranged with central axes approximately vertical.

10. An engine-driven hand-held power tool according to claim 5, in which said elastomeric material has a durometer value of between 35 and 55.

11. An engine-driven hand-held power tool according to claim 10, in which the durometer value of said elastomeric material is between 40 and 45.

12. An engine-driven hand-held power tool according to claim 5, in which said mounting means comprises three of said isolators supporting the front portion of the engine and a fourth said isolator supporting the rear portion of said engine on said supporting structure.

13. An engine-driven hand-held power tool according to claim 12, in which said isolator at the rear portion of the engine and one of said isolators at the front portion of the engine are arranged with a central axis of the isolator vertical.

* * * * *